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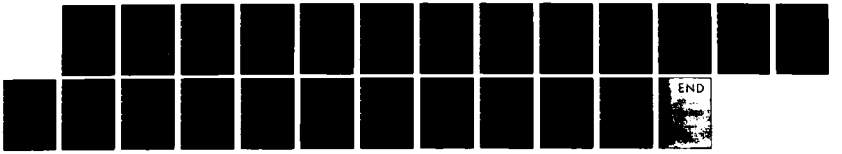

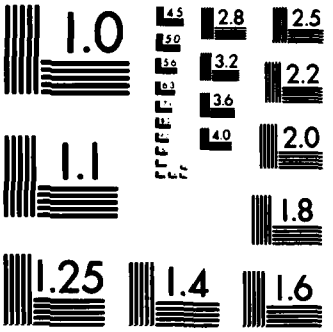

AFGL-TR-83-0334(II)

(12)

OPERATIONAL TACTICAL DECISION AID (OTDA) FOR INFRARED (8-12 μm) SYSTEMS - MARK II MANUAL VERSION

Appendix A - Atmospheric Transmission Tables

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September 30, 1983

Scientific Report No. 8

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

This technical report has been reviewed and is approved for publication

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FOR THE COMMANDER

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Atmospheric Sciences Division

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TACTICAL DECISION AID	AEROSOL EXTINCTION COEFFICIENT
INFRARED	PRECIPITATION EXTINCTION COEFFICIENT
LOWTRAN	RAIN EXTINCTION COEFFICIENT
ATMOSPHERIC TRANSMISSION	SNOW EXTINCTION COEFFICIENT
MOLECULAR EXTINCTION COEFFICIENT	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The tables required to calculate 8-12 μm atmospheric transmission at 4 km range for use in determining maximum lock-on range (MLOR) and maximum acquisition range (AR) from the Manual Version of the IR OTDA are presented. Tables adapted from AFGL models for calculating molecular, aerosol, and precipitation extinction coefficients as functions of various meteorological parameters are presented. An aerosol model selection procedure is provided as well as a table which converts total extinction coefficient to atmospheric transmission.

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PREFACE

This publication consists of a basic report and four appendixes, each issued as a separate document.

This format will facilitate operational use by accommodating the sizeable bulk of the materials presented and the CONFIDENTIAL security classification of Appendix D.

* * * *

The material contained herein is unchanged from Appendix A of SASC Report No. 3. The content of the appendix was the work of the co-authors of SASC Report No. 3, and the contributions of S. D. Hamilton, R. E. Hood, and R. F. Wachtmann are hereby acknowledged.

Another collaborator in this appendix was B. A. Mareiro, Jr.

Special thanks are due to Lt. Col. R. Wright, Lt. Col. K. Wantzloeben, Maj. W. Smith, Maj. J. Elrick and other representatives of Hq. Air Weather Service who continually enriched our understanding of the operator's problems.

Throughout the study we were supported and guided by the AFGL Contract Managers: Lt. Col. K. G. Cottrell to 2 May 1983, then Mr. R. V. Cormier.

The report was typed by D. M. Connor.

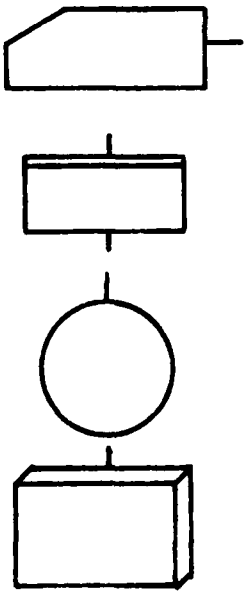
TABLE OF CONTENTS

1. A Brief Description of the Aerosol Selection Process

The methodology is based on the properties of three non-fog aerosol models in LOWTRAN. The Rural Model describes the basic background aerosol contained in all airmasses. The Maritime Model describes the aerosol that exists in airmasses with a maritime history when the marine aerosol (mostly sea salt) is superimposed in significant concentrations on the background aerosol. The Urban Model describes aerosol properties when certain types of urban pollutants are superimposed on the background aerosol. Under certain conditions, a maritime aerosol may also contain the urban component. In this case, since the maritime aerosol produces the strongest 8-12 μm extinction of the above three aerosol conditions, the Maritime Model takes precedence over the Urban Model.

This algorithm quantifies the aerosol model selection on the basis of the history of the airmass expected over the target. The algorithm is based on a large body of published scientific literature on atmospheric aerosols; however, certain selection criteria (e.g., the overwater distance for transformation of the continental aerosol into maritime characteristics) are based on very limited quantities of observational data. Experience by users and publication of additional scientific data will undoubtedly lead to modification of at least some of these criteria.

In using the flow charts in Fig. A-1, the basic rule is to always move downward in each figure. The following are key symbols to aid in interpretation of the charts:



represents the input of data

represents the entry into one of several alternate paths through the diagram

represents a connecting point to some other part of the diagram

represents selection of a particular "dry aerosol" model

Figure A-1A

a. Separates airmass by origin.

b. Treats the possible transformation of airmasses with a continental origin so that their aerosol assumes the extinction properties of a maritime aerosol.

Figure A-1B treats mechanisms for removal of the sea-salt aerosol from maritime airmasses, namely, sedimentation and washout. When these processes are effective, the aerosol tends to return to rural-like properties.

Figures A-1C and A-1D treat the problem of determining when the urban model should be used to describe a polluted rural aerosol.

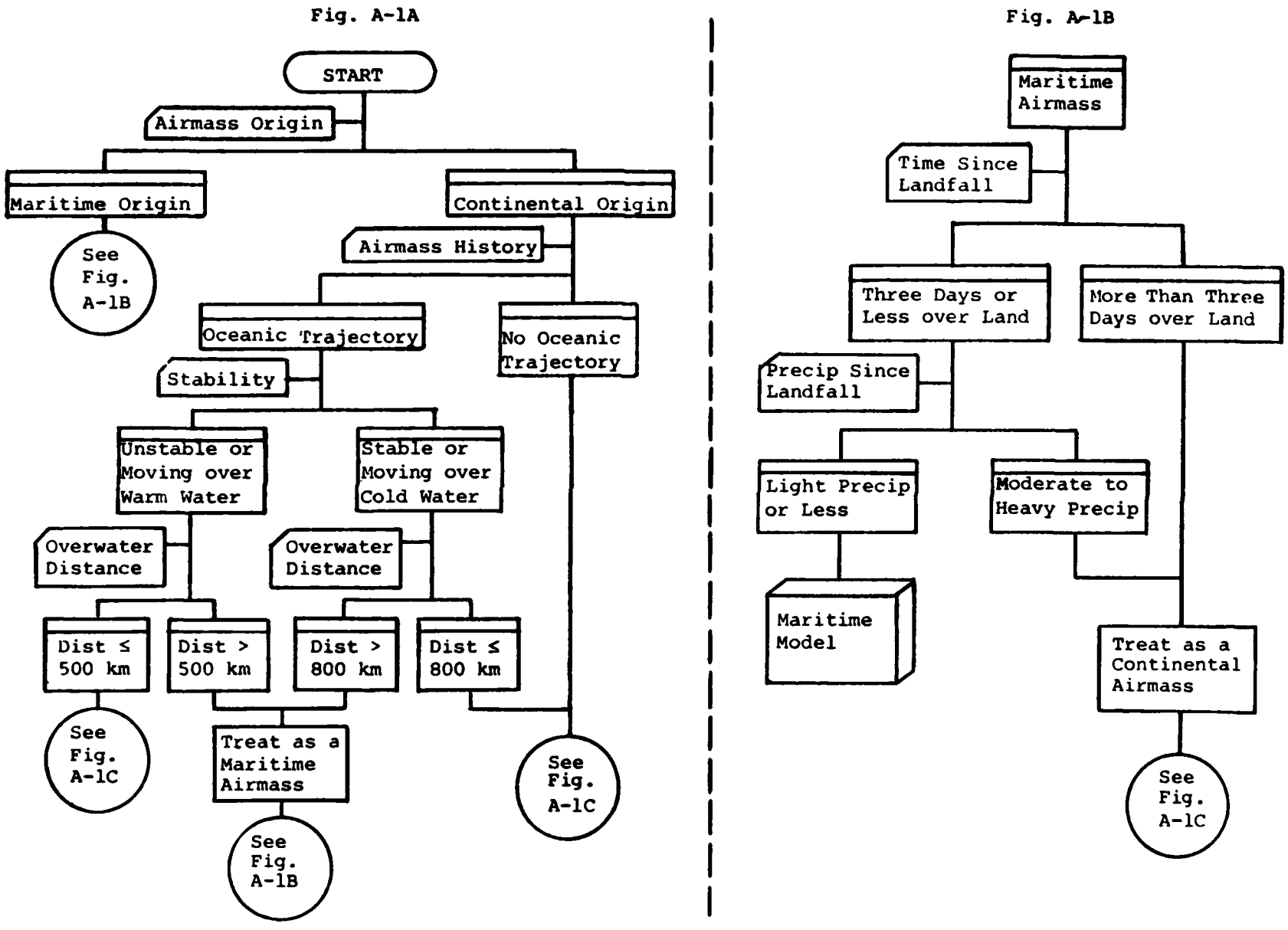


Fig. A-1. The Aerosol Model Selection Process

Fig. A-1C

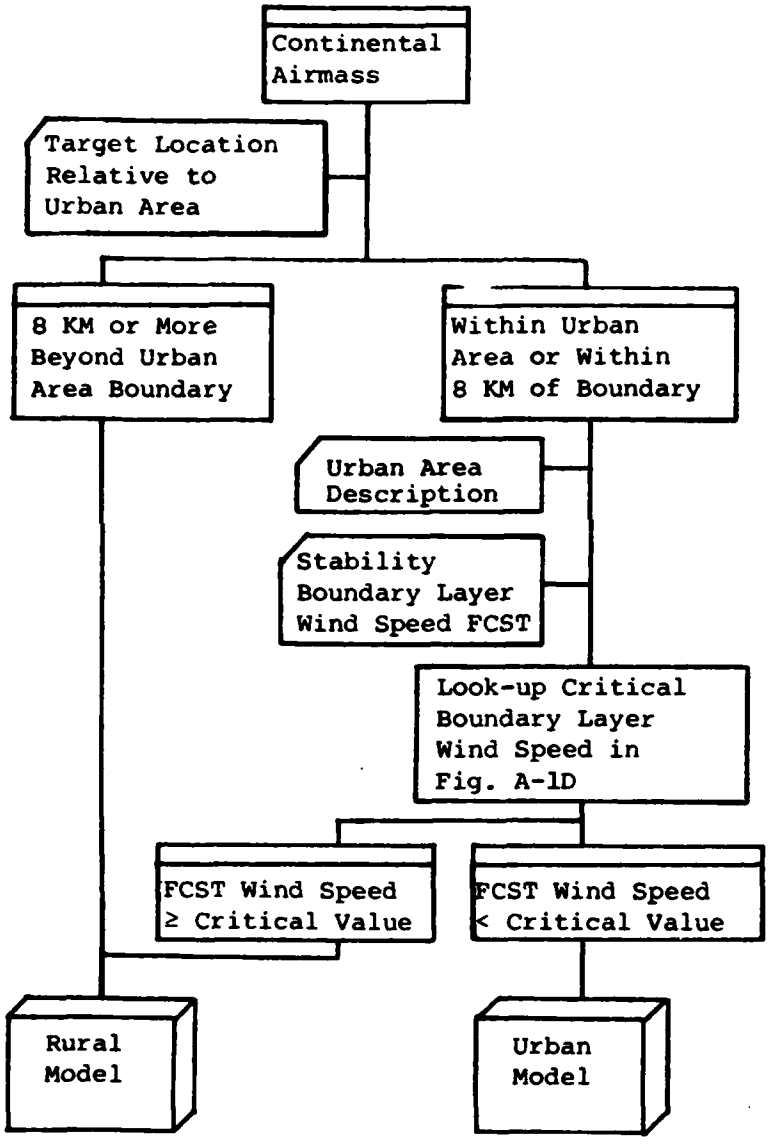


Fig. A-1D

Stability Condition	Critical Wind Speed (Knots)	
	Large and Heavily Industrialized Urban Areas (Area > 2000 KM^2)	Small - Medium Urban Areas or Large Areas Without Heavy Industrialization
Unstable	4	3
Neutral	8	5
Stable	25	15

Definitions of Stability:

1) Unstable: Lapse rate near dry adiabatic in lowest 1.5-2.0 KM enhances vertical diffusion.

2) Neutral: Lapse rate near the pseudo-adiabatic lapse rate or slightly more stable in the lowest 1.5-2.0 KM, with perhaps a weak inversion in the lowest 2 KM.

3) Stable: A strong inversion below 2 KM inhibits turbulent vertical diffusion.

Fig. A-1D. Approximate values of critical boundary layer wind speed (knots) for use of the urban aerosol model. Wind speed is tabulated against the size of the urban area and the stability condition. Definitions of stability categories are given above.

Fig. A-1 (Continued)

SNOW INTENSITY	VISIBILITY (KM)	EXTINCTION COEFFICIENT
HEAVY	.2	24.450
	.4	12.225
MODERATE	.6	8.150
	.8	6.113
	1.0	4.890
	1.5	3.260
	2.0	2.445
	2.5	1.956
	3.0	1.630
	4.0	1.223
LIGHT	5.0	.978
	6.0	.815
	7.0	.699
	8.0	.611
	9.0	.543
	10.0	.489
	15.0	.326
	20.0	.245

TABLE A-1A. PRECIPITATION EXTINCTION COEFFICIENT (B_p)

SNOW MODEL

RAIN INTENSITY	RAINFALL RATE (IN/HR)	EXTINCTION COEFFICIENT
	.01	.154
LIGHT	.05	.424
	.10	.657
	.15	.848
	.20	1.016
MODERATE	.25	1.170
	.30	1.312
	.35	1.446
	.40	1.573
	.45	1.694
	.50	1.810
	.55	1.922
	.60	2.030
HEAVY	.65	2.135
	.70	2.237
	.75	2.337
	.80	2.434
	.85	2.529
	.90	2.621
	.95	2.712
	1.00	2.801

TABLE A-1B. PRECIPITATION EXTINCTION COEFFICIENT (B_p)

RAIN MODEL

TEMPERATURE (C)

DEW POINT	-40	-39	-38	-37	-36	-35	-34	-33	-32	-31	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21
-65	5	5	4	4	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1
-64	6	5	5	4	4	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1
-63	7	6	6	5	5	4	4	3	3	3	3	2	2	2	2	2	1	1	1	1
-62	8	7	6	6	5	5	4	4	3	3	3	3	2	2	2	2	2	2	1	1
-61	9	8	7	6	6	5	5	4	4	4	3	3	3	2	2	2	2	2	2	1
-60	10	9	8	7	7	6	5	5	4	4	4	3	3	3	3	2	2	2	2	2
-59	11	10	9	8	8	7	6	6	5	5	4	4	3	3	3	3	2	2	2	2
-58	13	12	10	9	9	8	7	6	6	5	5	4	4	4	3	3	3	3	2	2
-57	15	13	12	11	10	9	8	7	7	6	5	5	4	4	4	3	3	3	3	2
-56	16	15	13	12	11	10	9	8	7	7	6	6	5	5	4	4	4	3	3	3
-55	19	17	15	14	12	11	10	9	8	8	7	6	6	5	5	4	4	4	3	3
-54	21	19	17	15	14	13	11	10	9	9	8	7	6	6	5	5	4	4	4	3
-53	24	21	19	17	16	14	13	12	11	10	9	8	7	7	6	6	5	5	4	4
-52	27	24	22	20	18	16	15	13	12	11	10	9	8	7	7	6	6	5	5	4
-51	30	27	24	22	20	18	16	15	13	12	11	10	9	8	8	7	6	6	5	5
-50	34	30	27	25	22	20	18	17	15	14	12	11	10	9	9	8	7	7	6	6
-49	38	34	31	28	25	23	21	19	17	15	14	13	12	11	10	9	8	7	7	6
-48	42	38	34	31	28	25	23	21	19	17	16	14	13	12	11	10	9	8	8	7
-47	47	42	38	35	31	28	26	23	21	19	17	16	15	13	12	11	10	9	8	8
-46	53	47	43	39	35	32	29	26	24	21	20	18	16	15	13	12	11	10	9	9
-45	59	53	48	43	39	35	32	29	26	24	22	20	18	16	15	14	13	11	11	10
-44	65	59	53	48	44	39	36	32	29	27	24	22	20	18	17	15	14	13	12	11
-43	73	66	59	54	48	44	40	36	33	30	27	25	22	20	19	17	16	14	13	12
-42	81	73	66	60	54	49	44	40	36	33	30	27	25	23	21	19	17	16	15	13
-41	90	81	73	66	60	54	49	45	40	37	33	30	28	25	23	21	19	18	16	15
-40	100	90	81	74	67	60	55	49	45	41	37	34	31	28	26	23	21	20	18	16
-39	***	100	90	82	74	67	61	55	50	45	41	37	34	31	28	26	24	22	20	18
-38	***	***	100	90	82	74	67	61	55	50	46	42	38	34	31	29	26	24	22	20
-37	***	***	***	100	90	82	74	67	61	56	50	46	42	38	35	32	29	27	24	22
-36	***	***	***	***	100	91	82	74	68	61	56	51	46	42	39	35	32	29	27	25
-35	***	***	***	***	***	100	91	82	75	68	62	56	51	47	43	39	36	32	30	27
-34	***	***	***	***	***	***	100	91	82	75	69	62	56	51	47	43	39	36	33	30
-33	***	***	***	***	***	***	***	100	91	82	75	68	62	57	52	47	43	40	36	33
-32	***	***	***	***	***	***	***	***	100	91	83	75	69	62	57	52	48	44	40	37
-31	***	***	***	***	***	***	***	***	***	100	91	83	75	69	63	57	52	48	44	40
-30	***	***	***	***	***	***	***	***	***	***	100	91	83	76	69	63	58	53	48	44
-29	***	***	***	***	***	***	***	***	***	***	***	100	91	83	76	69	63	58	53	49
-28	***	***	***	***	***	***	***	***	***	***	***	***	100	91	83	76	69	64	58	53
-27	***	***	***	***	***	***	***	***	***	***	***	***	***	100	91	83	76	70	64	58
-26	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	91	83	76	70	64
-25	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	91	84	77	70
-24	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	91	84	77
-23	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	92	84
-22	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	92
-21	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100

TABLE A-2. RELATIVE HUMIDITY (RH)

TEMPERATURE (°)

DEW POINT	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
-45	9	8	7	7	6	6	5	5	5	4	4	4	3	3	3	3	2	2	2	2
-44	10	9	8	8	7	6	6	5	5	5	4	4	4	3	3	3	3	3	2	2
-43	11	10	9	8	8	7	7	6	6	5	5	4	4	4	4	3	3	3	3	2
-42	12	11	10	9	9	8	7	7	6	6	5	5	5	4	4	4	3	3	3	3
-41	14	12	11	11	10	9	8	8	7	6	6	5	5	5	4	4	4	3	3	3
-40	15	14	13	12	11	10	9	8	8	7	7	6	6	5	5	4	4	4	4	3
-39	17	15	14	13	12	11	10	9	9	8	7	7	6	6	5	5	5	4	4	4
-38	18	17	16	14	13	12	11	10	9	9	8	7	7	6	6	5	5	5	4	4
-37	20	19	17	16	15	13	12	11	11	10	9	8	8	7	7	6	6	5	5	5
-36	23	21	19	18	16	15	14	13	12	11	10	9	8	8	7	7	6	6	5	5
-35	25	23	21	19	18	16	15	14	13	12	11	10	9	9	8	7	7	6	6	6
-34	28	25	23	21	20	18	17	15	14	13	12	11	10	10	9	8	8	7	7	6
-33	30	28	26	24	22	20	18	17	16	14	13	12	11	11	10	9	8	8	7	7
-32	34	31	28	26	24	22	20	19	17	16	15	14	13	12	11	10	9	9	8	7
-31	37	34	31	29	26	24	22	21	19	17	16	15	14	13	12	11	10	9	9	8
-30	41	37	34	31	29	27	24	23	21	19	18	16	15	14	13	12	11	10	10	9
-29	45	41	38	34	32	29	27	25	23	21	19	18	17	15	14	13	12	11	11	10
-28	49	45	41	38	35	32	30	27	25	23	21	20	18	17	16	15	13	12	12	11
-27	54	49	45	42	38	35	32	30	28	25	23	22	20	19	17	16	15	14	13	12
-26	59	54	50	46	42	39	35	33	30	28	26	24	22	20	19	17	16	15	14	13
-25	64	59	54	50	46	42	39	36	33	30	28	26	24	22	21	19	18	16	15	14
-24	70	65	59	55	50	46	42	39	36	33	31	28	26	24	23	21	19	18	17	15
-23	77	71	65	60	55	50	46	43	39	36	34	31	29	27	25	23	21	20	18	17
-22	84	77	71	65	60	55	51	47	43	40	37	34	31	29	27	25	23	21	20	18
-21	92	84	77	71	65	60	55	51	47	43	40	37	34	32	29	27	25	23	22	20
-20	100	92	84	77	71	66	60	56	51	47	44	40	37	35	32	30	28	26	24	22
-19	***	100	92	84	78	71	66	61	56	52	48	44	41	38	35	32	30	28	26	24
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-17	***	***	***	100	92	85	78	72	66	61	56	52	48	45	41	38	36	33	31	28
-16	***	***	***	***	100	92	85	78	72	67	61	57	52	49	45	42	39	36	33	31
-15	***	***	***	***	***	100	92	85	78	72	67	62	57	53	49	45	42	39	36	34
-14	***	***	***	***	***	***	100	92	85	78	72	67	62	57	53	49	45	42	39	36
-13	***	***	***	***	***	***	***	100	92	85	79	73	67	62	58	53	49	46	43	40
-12	***	***	***	***	***	***	***	***	100	92	85	79	73	67	62	58	54	50	46	43
-11	***	***	***	***	***	***	***	***	***	100	92	85	79	73	68	63	58	54	50	46
-10	***	***	***	***	***	***	***	***	***	***	100	92	85	79	73	68	63	58	54	50
-9	***	***	***	***	***	***	***	***	***	***	***	100	92	86	79	73	68	63	59	54
-8	***	***	***	***	***	***	***	***	***	***	***	***	100	93	86	79	74	68	63	59
-7	***	***	***	***	***	***	***	***	***	***	***	***	***	100	93	86	80	74	68	64
-6	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	93	86	80	74	69
-5	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	93	86	80	74
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-3	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	93	86
-2	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	93
-1	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100

TABLE A-2. RELATIVE HUMIDITY (RH)

TEMPERATURE (C)

DEW POINT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
-25	13	12	11	11	10	9	9	8	7	7	7	6	6	5	5	5	4	4	4	4
-24	14	13	12	12	11	10	9	9	8	8	7	7	6	6	5	5	5	4	4	4
-23	16	15	14	13	12	11	10	10	9	8	8	7	7	6	6	6	5	5	5	4
-22	17	16	15	14	13	12	11	10	10	9	9	8	7	7	7	6	6	5	5	5
-21	19	17	16	15	14	13	12	11	11	10	9	9	8	8	7	7	6	6	5	5
-20	20	19	18	16	15	14	13	12	12	11	10	9	9	8	8	7	7	6	6	6
-19	22	21	19	18	17	16	15	14	13	12	11	10	10	9	8	8	7	7	7	6
-18	24	23	21	20	18	17	16	15	14	13	12	11	10	10	9	9	8	8	7	7
-17	26	25	23	21	20	18	17	16	15	14	13	12	11	11	10	9	9	8	8	7
-16	29	27	25	23	22	20	19	17	16	15	14	13	12	12	11	10	10	9	8	8
-15	31	29	27	25	23	22	20	19	18	17	15	14	13	13	12	11	10	10	9	9
-14	34	31	29	27	25	24	22	21	19	18	17	16	15	14	13	12	11	11	10	9
-13	37	34	32	30	28	26	24	22	21	19	18	17	16	15	14	13	12	11	11	10
-12	40	37	34	32	30	28	26	24	23	21	20	18	17	16	15	14	13	12	12	11
-11	43	40	37	35	32	30	28	26	24	23	21	20	19	17	16	15	14	13	13	12
-10	47	43	40	38	35	33	30	28	27	25	23	22	20	19	18	17	16	15	14	13
-9	51	47	44	41	38	35	33	31	29	27	25	23	22	20	19	18	17	16	15	14
-8	55	51	47	44	41	38	36	33	31	29	27	25	24	22	21	19	18	17	16	15
-7	59	55	51	48	44	41	39	36	34	31	29	27	26	24	22	21	20	18	17	16
-6	64	59	55	51	48	45	42	39	36	34	32	30	28	26	24	23	21	20	19	17
-5	69	64	60	55	52	48	45	42	39	36	34	32	30	28	26	24	23	21	20	19
-4	74	69	64	60	56	52	48	45	42	39	37	34	32	30	28	26	25	23	22	20
-3	80	74	69	65	60	56	52	49	45	42	40	37	35	32	30	28	27	25	23	22
-2	86	80	75	69	65	60	56	52	49	46	43	40	37	35	33	31	29	27	25	24
-1	93	86	80	75	70	65	61	56	53	49	46	43	40	38	35	33	31	29	27	25
0	100	93	87	81	75	70	65	61	57	53	49	46	43	40	38	35	33	31	29	27
1	***	100	93	87	81	75	70	65	61	57	53	50	47	44	41	38	36	33	31	29
2	***	***	100	93	87	81	75	70	66	61	57	53	50	47	44	41	38	36	34	32
3	***	***	***	100	93	87	81	75	70	66	61	57	54	50	47	44	41	39	36	34
4	***	***	***	***	100	93	87	81	76	71	66	62	58	54	50	47	44	42	39	37
5	***	***	***	***	***	100	93	87	81	76	71	66	62	58	54	51	48	45	42	39
6	***	***	***	***	***	***	100	93	87	81	76	71	66	62	58	54	51	48	45	42
7	***	***	***	***	***	***	***	100	93	87	81	76	71	67	62	58	55	51	48	45
8	***	***	***	***	***	***	***	***	100	93	87	82	76	71	67	63	59	55	51	48
9	***	***	***	***	***	***	***	***	***	100	93	87	82	76	71	67	63	59	55	52
10	***	***	***	***	***	***	***	***	***	***	100	93	87	82	77	72	67	63	59	55
11	***	***	***	***	***	***	***	***	***	***	***	100	94	87	82	77	72	67	63	59
12	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88	82	77	72	67	63
13	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88	82	77	72	68
14	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88	82	77	72
15	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88	82	77
16	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88	82
17	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	88
18	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94
19	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100

TABLE A-2. RELATIVE HUMIDITY (RH)

DEW POINT	TEMPERATURE (°C)																			
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
-5	18	17	16	15	14	13	12	11	11	10	10	9	8	8	8	7	7	6	6	6
-4	19	18	17	16	15	14	13	12	12	11	10	10	9	9	8	8	7	7	6	6
-3	21	19	18	17	16	15	14	13	13	12	11	10	10	9	9	8	8	7	7	7
-2	22	21	20	18	17	16	15	14	14	13	12	11	11	10	9	9	8	8	7	7
-1	24	22	21	20	19	17	16	15	15	14	13	12	11	11	10	10	9	9	8	8
0	26	24	23	21	20	19	18	17	16	15	14	13	12	12	11	10	10	9	9	8
1	28	26	24	23	22	20	19	18	17	16	15	14	13	12	12	11	10	10	9	9
2	30	28	26	25	23	22	20	19	18	17	16	15	14	13	13	12	11	11	10	9
3	32	30	28	26	25	23	22	21	19	18	17	16	15	14	14	13	12	11	11	10
4	34	32	30	28	27	25	24	22	21	20	18	17	16	15	15	14	13	12	12	11
5	37	35	32	30	29	27	25	24	22	21	20	19	18	17	16	15	14	13	12	12
6	39	37	35	33	31	29	27	26	24	23	21	20	19	18	17	16	15	14	13	13
7	42	40	37	35	33	31	29	27	26	24	23	21	20	19	18	17	16	15	14	13
8	45	43	40	38	35	33	31	29	28	26	24	23	22	20	19	18	17	16	15	14
9	49	46	43	40	38	35	33	31	30	28	26	25	23	22	21	19	18	17	16	15
10	52	49	46	43	40	38	36	34	32	30	28	26	25	23	22	21	20	19	17	17
11	56	52	49	46	43	41	38	36	34	32	30	28	27	25	24	22	21	20	19	18
12	59	56	52	49	46	43	41	38	36	34	32	30	28	27	25	24	22	21	20	19
13	63	60	56	53	49	46	44	41	39	36	34	32	30	29	27	25	24	23	21	20
14	68	64	60	56	53	50	47	44	41	39	37	35	33	31	29	27	26	24	23	22
15	72	68	64	60	56	53	50	47	44	42	39	37	35	33	31	29	27	26	24	23
16	77	73	68	64	60	57	53	50	47	44	42	39	37	35	33	31	29	28	26	25
17	83	77	73	68	64	60	57	53	50	47	45	42	40	37	35	33	31	29	28	26
18	88	83	78	73	68	64	61	57	54	50	48	45	42	40	37	35	33	31	30	28
19	94	88	83	78	73	69	65	61	57	54	51	48	45	42	40	38	36	34	32	30
20	100	94	88	83	78	73	69	65	61	57	54	51	48	45	43	40	38	36	34	32
21	***	100	94	88	83	78	73	69	65	61	57	54	51	48	45	43	40	38	36	34
22	***	***	100	94	88	83	78	73	69	65	61	58	54	51	48	46	43	41	38	36
23	***	***	***	100	94	88	83	78	74	69	65	61	58	55	51	48	46	43	41	38
24	***	***	***	***	100	94	88	83	78	74	69	65	62	58	55	52	49	46	43	41
25	***	***	***	***	***	100	94	88	83	78	74	70	65	62	58	55	52	49	46	43
26	***	***	***	***	***	***	100	94	89	83	78	74	70	66	62	58	55	52	49	46
27	***	***	***	***	***	***	***	100	94	89	83	79	74	70	66	62	58	55	52	49
28	***	***	***	***	***	***	***	***	100	94	89	83	79	74	70	66	62	59	55	52
29	***	***	***	***	***	***	***	***	***	100	94	89	84	79	74	70	66	62	59	55
30	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79	74	70	66	62	59
31	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79	74	70	66	63
32	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79	75	70	66
33	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79	75	70
34	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79	75
35	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84	79
36	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89	84
37	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94	89
38	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100	94
39	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	100

TABLE A-2. RELATIVE HUMIDITY (RH)

VSBY (KM)	RELATIVE HUMIDITY														
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	=>99
1.5	.556	.566	.578	.591	.605	.621	.639	.660	.685	.714	.751	.797	.862	.961	1.159
2.0	.420	.428	.437	.447	.458	.470	.484	.500	.519	.541	.569	.605	.655	.731	.883
2.5	.338	.345	.352	.360	.368	.378	.390	.403	.418	.436	.458	.488	.527	.590	.713
3.0	.282	.288	.294	.301	.308	.316	.326	.336	.349	.364	.383	.408	.442	.494	.598
4.0	.212	.216	.221	.226	.232	.238	.245	.253	.263	.274	.289	.307	.333	.372	.451
5.0	.170	.173	.177	.181	.185	.191	.196	.203	.211	.220	.231	.246	.267	.299	.362
6.0	.141	.144	.147	.151	.154	.159	.163	.169	.175	.183	.193	.205	.222	.249	.302
7.0	.121	.123	.126	.129	.132	.136	.140	.145	.150	.157	.165	.176	.190	.213	.259
8.0	.106	.108	.110	.113	.115	.119	.122	.126	.131	.137	.144	.153	.166	.186	.226
9.0	.094	.096	.098	.100	.102	.105	.108	.112	.116	.121	.128	.136	.148	.165	.201
10.0	.084	.086	.088	.090	.092	.094	.097	.101	.104	.109	.115	.122	.133	.148	.180
15.0	.048	.049	.050	.051	.052	.053	.055	.057	.059	.062	.065	.069	.075	.084	.102
20.0	.029	.030	.031	.031	.032	.033	.034	.035	.036	.038	.040	.043	.046	.052	.063
30.0	.017	.017	.017	.018	.018	.019	.019	.020	.021	.021	.023	.024	.026	.029	.036
40.0	.012	.012	.012	.013	.013	.013	.014	.014	.015	.016	.016	.017	.019	.021	.026
50.0	.009	.009	.010	.010	.010	.010	.011	.011	.011	.012	.013	.013	.015	.016	.020

TABLE A-3A. AEROSOL EXTINCTION COEFFICIENT (B_{AER})
MARITIME MODEL

	RELATIVE HUMIDITY															
VSBY (KM)	<=10	30	50	55	60	65	70	72	74	76	78	80	81	82	83	84
1.5	.286	.296	.310	.314	.320	.326	.333	.359	.388	.423	.464	.513	.520	.528	.537	.546
2.0	.216	.223	.234	.238	.242	.246	.252	.271	.293	.319	.351	.388	.394	.399	.406	.413
2.5	.173	.179	.188	.191	.194	.198	.202	.217	.235	.257	.282	.312	.316	.321	.326	.332
3.0	.145	.150	.157	.159	.162	.165	.169	.182	.197	.214	.235	.260	.264	.268	.273	.277
4.0	.109	.113	.118	.120	.122	.124	.127	.136	.148	.161	.177	.196	.199	.202	.205	.209
5.0	.087	.090	.094	.096	.097	.099	.101	.109	.118	.129	.141	.157	.159	.161	.164	.167
6.0	.073	.075	.079	.080	.081	.083	.084	.091	.098	.107	.118	.130	.132	.134	.137	.139
7.0	.062	.064	.067	.068	.069	.071	.072	.078	.084	.092	.101	.112	.113	.115	.117	.119
8.0	.054	.056	.059	.059	.060	.062	.063	.068	.073	.080	.088	.097	.099	.100	.102	.104
9.0	.048	.050	.052	.053	.054	.055	.056	.060	.065	.071	.078	.086	.088	.089	.091	.092
10.0	.043	.045	.047	.047	.048	.049	.050	.054	.058	.064	.070	.078	.079	.080	.081	.083
15.0	.024	.025	.026	.027	.027	.028	.028	.031	.033	.036	.040	.044	.045	.045	.046	.047
20.0	.015	.016	.016	.016	.017	.017	.017	.019	.020	.022	.024	.027	.027	.028	.028	.029
30.0	.008	.009	.009	.009	.009	.010	.010	.011	.011	.013	.014	.015	.015	.016	.016	.016
40.0	.006	.006	.007	.007	.007	.007	.007	.008	.008	.009	.010	.011	.011	.011	.012	.012
50.0	.005	.005	.005	.005	.005	.005	.005	.006	.006	.007	.008	.009	.009	.009	.009	.009

TABLE A-3A. AEROSOL EXTINCTION COEFFICIENT (B_{AER})
MARITIME MODEL

VSBY (KM)	RELATIVE HUMIDITY													
	<=50	55	60	65	70	75	80	85	90	92	94	96	98	=>99
1.5	.260	.260	.260	.260	.260	.251	.240	.243	.247	.249	.253	.257	.264	.272
2.0	.195	.195	.195	.195	.195	.188	.180	.182	.185	.187	.189	.193	.198	.204
2.5	.156	.156	.156	.156	.156	.151	.144	.146	.148	.150	.151	.154	.159	.163
3.0	.130	.130	.130	.130	.130	.125	.120	.121	.123	.125	.126	.128	.132	.136
4.0	.097	.098	.098	.098	.098	.094	.090	.091	.092	.093	.094	.096	.099	.102
5.0	.078	.078	.078	.078	.078	.075	.072	.073	.074	.074	.075	.077	.079	.081
6.0	.065	.065	.065	.065	.065	.062	.060	.060	.061	.062	.063	.064	.066	.067
7.0	.055	.055	.055	.055	.055	.053	.051	.052	.052	.053	.054	.054	.056	.058
8.0	.048	.048	.048	.048	.048	.047	.044	.045	.046	.046	.047	.047	.049	.050
9.0	.043	.043	.043	.043	.043	.041	.039	.040	.041	.041	.041	.042	.043	.045
10.0	.038	.038	.038	.038	.038	.037	.035	.036	.036	.037	.037	.038	.039	.040
15.0	.022	.022	.022	.022	.022	.021	.020	.020	.021	.021	.021	.021	.022	.023
20.0	.013	.013	.013	.013	.013	.013	.012	.012	.013	.013	.013	.013	.013	.014
30.0	.008	.008	.008	.008	.008	.007	.007	.007	.007	.007	.007	.007	.008	.008
40.0	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005	.006	.006
50.0	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004

TABLE A-3B. AEROSOL EXTINCTION COEFFICIENT (B_{AER})
URBAN MODEL

VSBY (KM)	RELATIVE HUMIDITY													
	<=50	55	60	65	70	75	80	85	90	92	94	96	98	=>99
1.5	.232	.232	.232	.233	.233	.234	.234	.240	.249	.254	.261	.271	.288	.307
2.0	.175	.175	.176	.176	.176	.176	.177	.181	.188	.191	.196	.203	.216	.230
2.5	.141	.141	.141	.141	.141	.142	.142	.145	.150	.153	.157	.163	.173	.184
3.0	.117	.118	.118	.118	.118	.118	.118	.121	.125	.128	.131	.136	.144	.153
4.0	.088	.088	.088	.089	.089	.089	.089	.091	.094	.096	.098	.102	.108	.115
5.0	.071	.071	.071	.071	.071	.071	.071	.073	.075	.077	.078	.081	.086	.092
6.0	.059	.059	.059	.059	.059	.059	.059	.060	.063	.064	.065	.067	.072	.076
7.0	.050	.050	.050	.050	.051	.051	.051	.052	.053	.054	.056	.058	.061	.065
8.0	.044	.044	.044	.044	.044	.044	.044	.045	.047	.048	.049	.050	.053	.057
9.0	.039	.039	.039	.039	.039	.039	.039	.040	.041	.042	.043	.045	.047	.050
10.0	.035	.035	.035	.035	.035	.035	.035	.036	.037	.038	.039	.040	.042	.045
15.0	.020	.020	.020	.020	.020	.020	.020	.020	.021	.021	.022	.023	.024	.026
20.0	.012	.012	.012	.012	.012	.012	.012	.012	.013	.013	.013	.014	.015	.016
30.0	.007	.007	.007	.007	.007	.007	.007	007	.007	.007	.008	.008	.008	.009
40.0	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005	.006	.006	.006
50.0	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.005	.005

TABLE A-3C. AEROSOL EXTINCTION COEFFICIENT (B_{AER})
RURAL MODEL

VISIBILITY (KM)	EXTINCTION COEFFICIENT
.1	9.999
.2	5.319
.5	2.264
1.0	1.164

TABLE A-3D. AEROSOL EXTINCTION COEFFICIENT (B_{AER})

FOG MODEL

TEMPERATURE (C)

DEW POINT	-30.	-15.	0.	5.	10.	15.	20.	22.	24.	26.	28.	30.	32.	34.	36.	38.	40.
-30.	.029	.027	.026	.025	.025	.024	.024	.024	.024	.023	.023	.023	.023	.022	.022	.022	.022
-29.	*****	.028	.026	.026	.026	.025	.025	.025	.024	.024	.024	.024	.024	.023	.023	.023	.023
-28.	*****	.028	.027	.027	.026	.026	.025	.025	.025	.025	.025	.025	.024	.024	.024	.024	.024
-27.	*****	.029	.028	.027	.027	.026	.026	.026	.026	.026	.026	.025	.025	.025	.025	.025	.025
-26.	*****	.029	.028	.028	.027	.027	.027	.027	.027	.027	.026	.026	.026	.026	.026	.026	.026
-25.	*****	.030	.029	.028	.028	.028	.028	.028	.027	.027	.027	.027	.027	.027	.027	.027	.027
-24.	*****	.031	.030	.029	.029	.029	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028
-23.	*****	.032	.030	.030	.030	.029	.029	.029	.029	.029	.029	.029	.029	.029	.029	.029	.029
-22.	*****	.033	.031	.031	.030	.030	.030	.030	.030	.030	.030	.030	.030	.029	.029	.029	.029
-21.	*****	.034	.032	.032	.031	.031	.031	.031	.031	.030	.030	.030	.030	.030	.030	.030	.030
-20.	*****	.035	.033	.032	.032	.032	.032	.031	.031	.031	.031	.031	.031	.031	.031	.031	.031
-19.	*****	.036	.034	.033	.033	.033	.032	.032	.032	.032	.032	.032	.032	.032	.032	.032	.032
-18.	*****	.038	.035	.035	.034	.034	.033	.033	.033	.033	.033	.033	.033	.033	.033	.033	.033
-17.	*****	.039	.036	.036	.035	.035	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034
-16.	*****	.041	.038	.037	.036	.036	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035
-15.	*****	.043	.039	.038	.038	.037	.036	.036	.036	.036	.036	.036	.036	.036	.036	.036	.036
-14.	*****	*****	.041	.040	.039	.038	.038	.037	.037	.037	.037	.037	.037	.037	.037	.037	.036
-13.	*****	*****	.042	.041	.040	.040	.039	.039	.038	.038	.038	.038	.038	.038	.038	.038	.038
-12.	*****	*****	.044	.043	.042	.041	.040	.040	.040	.040	.039	.039	.039	.039	.039	.039	.039
-11.	*****	*****	.047	.045	.044	.043	.042	.042	.041	.041	.041	.041	.040	.040	.040	.040	.040
-10.	*****	*****	.049	.047	.046	.045	.044	.043	.043	.043	.042	.042	.042	.042	.041	.041	.041
-9.	*****	*****	.051	.050	.048	.047	.045	.045	.045	.044	.044	.044	.043	.043	.043	.043	.043
-8.	*****	*****	.054	.052	.050	.049	.048	.047	.047	.046	.046	.045	.045	.045	.045	.044	.044
-7.	*****	*****	.057	.055	.053	.051	.050	.049	.049	.048	.048	.047	.047	.047	.046	.046	.046
-6.	*****	*****	.060	.058	.056	.054	.052	.052	.051	.050	.050	.049	.049	.049	.048	.048	.048
-5.	*****	*****	.064	.061	.059	.057	.055	.054	.054	.053	.052	.052	.051	.051	.050	.050	.050
-4.	*****	*****	.068	.065	.062	.060	.058	.057	.056	.056	.055	.054	.054	.053	.053	.052	.052
-3.	*****	*****	.072	.069	.066	.063	.061	.060	.059	.059	.058	.057	.057	.056	.055	.055	.054
-2.	*****	*****	.077	.073	.070	.067	.065	.064	.063	.062	.061	.060	.060	.059	.058	.058	.057
-1.	*****	*****	.082	.078	.075	.071	.069	.067	.066	.065	.065	.065	.064	.063	.062	.061	.061	.060

TABLE A-4. MOLECULAR EXTINCTION COEFFICIENT (B_{MOL})

TEMPERATURE (C)

DEW POINT	-30.	-15.	0.	5.	10.	15.	20.	22.	24.	26.	28.	30.	32.	34.	36.	38.	40.
0.	*****	*****	.088	.084	.080	.076	.073	.072	.071	.069	.068	.067	.066	.066	.065	.064	.063
1.	*****	*****	*****	.089	.085	.081	.078	.076	.075	.074	.073	.072	.070	.069	.068	.068	.067
2.	*****	*****	*****	.096	.091	.087	.083	.081	.080	.079	.077	.076	.075	.074	.073	.072	.071
3.	*****	*****	*****	*****	.103	.098	.093	.088	.087	.085	.084	.082	.081	.080	.078	.077	.076	.075
4.	*****	*****	*****	*****	.110	.105	.099	.095	.093	.091	.089	.088	.086	.085	.083	.082	.081	.080
5.	*****	*****	*****	*****	.119	.112	.107	.101	.099	.097	.096	.094	.092	.091	.089	.088	.086	.085
6.	*****	*****	*****	*****	*****	.121	.115	.109	.107	.104	.102	.101	.099	.097	.095	.094	.092	.090
7.	*****	*****	*****	*****	*****	.130	.123	.117	.114	.112	.110	.108	.106	.104	.102	.100	.098	.096
8.	*****	*****	*****	*****	*****	.140	.133	.125	.123	.120	.118	.115	.113	.111	.109	.107	.105	.103
9.	*****	*****	*****	*****	*****	.151	.143	.135	.132	.129	.126	.124	.121	.119	.116	.114	.112	.110
10.	*****	*****	*****	*****	*****	.163	.154	.145	.142	.138	.135	.133	.130	.127	.125	.122	.120	.117
11.	*****	*****	*****	*****	*****	*****	.170	.159	.155	.151	.148	.144	.141	.137	.134	.131	.128	.126
12.	*****	*****	*****	*****	*****	*****	.186	.174	.169	.165	.161	.157	.153	.149	.146	.142	.139	.136
13.	*****	*****	*****	*****	*****	*****	.203	.190	.185	.180	.175	.171	.166	.162	.158	.155	.151	.147
14.	*****	*****	*****	*****	*****	*****	.222	.207	.201	.196	.191	.186	.181	.177	.172	.168	.164	.160
15.	*****	*****	*****	*****	*****	*****	.242	.226	.220	.214	.208	.203	.197	.192	.187	.183	.178	.174
16.	*****	*****	*****	*****	*****	*****	*****	.246	.240	.233	.227	.221	.215	.209	.204	.199	.193	.189
17.	*****	*****	*****	*****	*****	*****	*****	.269	.261	.254	.247	.240	.234	.228	.222	.216	.210	.205
18.	*****	*****	*****	*****	*****	*****	*****	.293	.284	.276	.269	.261	.254	.247	.241	.234	.228	.222
19.	*****	*****	*****	*****	*****	*****	*****	.319	.310	.301	.292	.284	.276	.269	.261	.254	.247	.241
20.	*****	*****	*****	*****	*****	*****	*****	.348	.337	.327	.318	.309	.300	.292	.284	.276	.268	.261
21.	*****	*****	*****	*****	*****	*****	*****	*****	.367	.356	.346	.336	.326	.317	.308	.299	.291	.283
22.	*****	*****	*****	*****	*****	*****	*****	*****	.400	.388	.376	.365	.354	.343	.334	.324	.315	.306
23.	*****	*****	*****	*****	*****	*****	*****	*****	*****	.423	.409	.395	.384	.373	.362	.351	.341	.331
24.	*****	*****	*****	*****	*****	*****	*****	*****	*****	.461	.446	.431	.418	.405	.392	.380	.369	.358
25.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.486	.470	.454	.439	.425	.412	.399	.387
26.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.531	.512	.495	.478	.462	.447	.433	.419
27.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.561	.540	.521	.503	.486	.469	.454
28.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.616	.592	.569	.548	.528	.510	.492
29.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.651	.626	.599	.576	.555	.535
30.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.722	.689	.659	.632	.606	.583
31.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.767	.729	.696	.665	.638
32.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	.867	.816	.773	.735	.701

TABLE A-4. MOLECULAR EXTINCTION COEFFICIENT (B_{MOL})

EXT COEF	TRANS	EXT COEF	TRANS	EXT COEF	TRANS	EXT COEF	TRANS	EXT COEF	TRANS	EXT COEF	TRANS
.01	.96	.23	.40	.45	.17	.67	.07	.89	.03	1.11	.01
.02	.92	.24	.38	.46	.16	.68	.07	.90	.03	1.12	.01
.03	.89	.25	.37	.47	.15	.69	.06	.91	.03	1.13	.01
.04	.85	.26	.35	.48	.15	.70	.06	.92	.03	1.14	.01
.05	.82	.27	.34	.49	.14	.71	.06	.93	.02	1.15	.01
.06	.79	.28	.33	.50	.14	.72	.06	.94	.02	1.16	.01
.07	.76	.29	.31	.51	.13	.73	.05	.95	.02	1.17	.01
.08	.73	.30	.30	.52	.12	.74	.05	.96	.02	1.18	.01
.09	.70	.31	.29	.53	.12	.75	.05	.97	.02	1.19	.01
.10	.67	.32	.28	.54	.12	.76	.05	.98	.02	1.20	.01
.11	.64	.33	.27	.55	.11	.77	.05	.99	.02	1.21	.01
.12	.62	.34	.26	.56	.11	.78	.04	1.00	.02	1.22	.01
.13	.59	.35	.25	.57	.10	.79	.04	1.01	.02	1.23	.01
.14	.57	.36	.24	.58	.10	.80	.04	1.02	.02	1.24	.01
.15	.55	.37	.23	.59	.09	.81	.04	1.03	.02	1.25	.01
.16	.53	.38	.22	.60	.09	.82	.04	1.04	.02	1.26	.01
.17	.51	.39	.21	.61	.09	.83	.04	1.05	.01	1.27	.01
.18	.49	.40	.20	.62	.08	.84	.03	1.06	.01	1.28	.01
.19	.47	.41	.19	.63	.08	.85	.03	1.07	.01	1.29	.01
.20	.45	.42	.19	.64	.08	.86	.03	1.08	.01	1.30	.01
.21	.43	.43	.18	.65	.07	.87	.03	1.09	.01	1.31	.01
.22	.41	.44	.17	.66	.07	.88	.03	1.10	.01	1.32	.01
										=>1.33	.00

TABLE A-5. ATMOSPHERIC TRANSMISSION (τ_{ATM}) AT REFERENCE RANGE (4 km)

END

FILMED

12-84

DTIC